843

Hemlock Slabs as a Source of Pulp and Tannin*

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INTRODUCTION

In recent years considerable attention has been directed toward developing new sources of domestic vegetable tanning materials to replace chestnut

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wood, which has been our principal domestic source but which is now disappearing due to the chestnut blight [1]. Our national defense authorities place vegetable tannin high on the list of critical materials necessary for a successful war effort. Should we in time of war be cut off from our main sources of supplies, our present domestic production would provide only a fraction of our needs. That fact, plus the marked downward trend in domestic production, is reason enough for sober concern.

To meet this deficit in domestic production, which still comes mainly from long-dead chestnut trees, investigators have proposed the utilization of scrub oaks in Florida [2], [3] and the mixed oaks of the Tennessee Valley [4], [5] as replacement sources of tannin. Other possible domestic sources proposed are the canaigre root [1] from the Southwest and bark from western hemlock [6] (Tsuga heterophylla (Raf.) Sarg.), Douglas fir, spruce and redwood of the West.

To this list of sources now being actively investigated should be added Eastern hemlock bark (Tsuga canadensis (L.) Carr.). (Perhaps it would be more accurate to say reinvestigated.) This is one of the oldest native sources of tannin in this country. [7]

In past years Michigan and Wisconsin have been important sources of peeled bark. Today this area alone supplies over 70 per cent of the hemlock cut in the eastern United States. It is estimated that the forests of Michigan and Wisconsin now contain about 1200 million cubic feet of hemlock with 75 per cent of this volume in Michigan. Fully 95 per cent of the hemlock growing in Michigan occurs in the Upper Peninsula. It is from this area that some 95 per cent of the peeled bark in the Lake States is produced. Thus our attention is directed to the Upper Peninsula of Michigan as the area that carries the greatest potential for any substantial increase in tannin production from hemlock bark in the eastern United States.

What are the reasons for the drop in consumption of hemlock bark from Michigan and Wisconsin within the last 25 years, from an estimated high of 63,000 cords in 1928 to some 4,400 cords in 1951? The main reason for this decline is that cost-conscious tanners have been able to secure other tanning materials at their plants for a lower cost per tan unit (1 pound of 100 per cent tannin) than from hemlock bark. Increasing freight charges and higher handling costs at the tanneries are both contributing to the unfavorable position of hemlock bark relative to other sources of vegetable tannins. As an example, the present delivered cost of a cord of bark from one of the important Upper Peninsula shipping points to a Lower Michigan tannery is $28.41 of which $11.41 is freight.

For the much longer freight hauls to tanneries in other states, delivered costs have made it economically impossible for some to continue using hemlock bark. Of the 36 companies in the United States who were the principal consumers of hemlock bark from Michigan and Wisconsin in the beginning of the period between 1918 to 1952, only ten are still using bark. The others may either have discontinued operating or changed over to cheaper per unit cost foreign substitutes, mainly quebracho and wattle extracts.

It would seem from the foregoing that the only apparent solution to the problem of increased use of the hemlock tannin resource available in the Upper Peninsula of Michigan would be its production there as a liquid or possibly a powdered extract. It is to be noted that during World War I a 100-cord per day hemlock bark extract plant was operated successfully in conjunction with a modern tannery in the Upper Peninsula at Escanaba, Michigan. However, in the post-war depression that followed it was unable to compete with foreign extracts and barks and consequently was dismantled. Although it has been suggested a number of times, as far as we know no one has thoroughly evaluated the feasibility of such a proposal in the light of present day conditions. The Forest Products Research Division of the Michigan College of Mining and Technology at Houghton, Michigan, decided in 1949 to investigate the economics of hemlock tannin extract production in the Upper Peninsula.

The first phase of this investigation dealt with a study of the potential market for hemlock tannin extract. Of nine American firms contacted, six were primarily sole leather producers operating 21 tanneries, and the other three were engaged mainly in upholstery, baggage or upper leather production at their respective tanneries. This study indicated an anitial market for 5,000 tons of 100 per cent hemlock tannin in a price range of 18-22 cents per tan unit. Most of the firms contacted wished to tie the price they were willing to pay for hemlock tannin with the going market cost of quebracho extract.

Several experts in tannin extraction were contacted, and from the data they furnished hemlock extract production costs were estimated at 16–16-½ cents per tan unit based on a delivered bark cost of $17.00 per cord, open tank leaching and a recovery of 160 tan units per cord. The indicated profit margin of 1½–2 cents based on an 18 cent per tan unit f.o.b. price was too small in our opinion to interest any substantial capital investment in such an enterprise. The problem of economic feasibility thus resolves itself into whether or not extract costs can be reduced either by improvement in processing or by lowering the cost of the bark. No appreciable reduction in the cost of hand-peeled bark from pulp or sawmill logs can be anticipated unless the pulpmills can be persuaded to pay a greater differential for peeled logs than has been their custom.

Another possible source of bark in the Upper Peninsula is the large volume of sawmill slabs and edgings developed annually. Many portable sawmills have been forced to burn their slabs for lack of a profitable market. In the winter of 1950–51, 21 sawmills in the Upper Peninsula were contacted. Their hemlock lumber production for 1950 approximated 57 million board feet.

From U. S. Forest service data the total hemlock lumber production in the Upper Peninsula in 1950 was estimated to be 116 million board feet. The mills contacted thus covered 49 per cent of the production for that year. These operators were willing to sell some 36,000 cords at a nominal price (average $4.00) f.o.b. cars. The full potential in the Upper Peninsula that year based on 0.7 cord of slabs and edgings per M board feet would have been 81,200 cords. Of course, a fair percentage of these slabs would not be economically available.

These waste slabs contain 35–40 per cent bark and 65–60 per cent wood. The tannin content of the whole slabs including both bark and wood is too low for commercial tannin extraction and the bark content is too high for most pulping purposes. It is doubtful that the value of either of these fractions alone if segregated would be sufficient to pay for the segregation, but if both products could be obtained at a saleable purity, their segregation might be commercially feasible. Work was therefore initiated on these hemlock slabs to study methods of recovering both a high bark fraction suitable for extraction of tanning material and a wood fraction of sufficiently high wood content in a marketable form for pulping.

Our current thinking may be summed up in a proposal to collect slabs at a central point in the Upper Peninsula of Michigan, chip them, segregate the bark for use in an extract plant (50 cord per day capacity) at the same location and dispose of the "bark free" wood chips to pulpmills either in the Upper Peninsula or in nearby Wisconsin. The initial capacity of such a slab processing plant should be at least 100 cords per day for which there is an ample supply of slabs now and in the foreseeable future.

A chipping and bark segregation test on seasoned hemlock slabs is reported here.

Principles of the Process

Dunwody has described a method for producing pulp chips from unbarked logs[9].

The method of segregating bark and wood in chip form on an air flotation specific gravity separator reported by Calderwood and May[2] and later by Snow[4] appeared promising and was used in this study with some modifications. The application of this method requires the following:

1. There must be a sufficiently high "floatability" difference between the bark and wood chips.
2. The chipper must effect a high degree of detachment of bark and wood during chipping.
3. The chipper must produce wood chips with uniform fiber length acceptable for pulping operations and uniform bark chips with a low fines content suitable for extraction.

Specific gravity measurements made on several samples of bark and wood as well as the denser knots, reported in Table I, show a specific gravity difference of 0.2 between the bark and wood, the bark being 45 per cent heavier than the wood.

TABLE I

Specific Gravity of Hemlock Bark and Wood From Air-Dried Slabs

	Specific Gravity	Moisture Content (Wet Basis)
Wood	0.44	10.7
Bark	0.64	10.3
Knots	1.00	8.5

There is, therefore, a sufficient difference in specific gravity together with a difference in shape between the bark and wood to permit their segregation by this method. To make the difference in specific gravity and shape of the chips effective, the chips must be classified by size before air flotation.

The knots have a much higher specific gravity than the bark and since the knot shapes approach those of the bark rather than the wood, the knots can be expected to be discharged at the end of the separator deck with the heaviest bark fractions. This assures a knot-free wood product.

Process

For this study a one-half cord lot of hemlock slabs was procured from a sawmill in the Upper Peninsula of Michigan. The slabs which had been stacked to air dry for at least one year and stored under cover for two months were chipped and screened into five fractions. The coarsest fraction. consisting mostly of knots, was discarded; the finest fraction, consisting largely of bark was added directly to the bark product; and the other three fractions were each segregated separately by air floatation into a heavy fraction (bark), a light fraction (wood) and a middling fraction (bark and wood) and each middling fraction refloated. All heavy fractions were combined with the finest screen fraction to make up the bark product for tannin extraction and all light fractions were combined to form the wood product for pulping.

Chip Preparation: Air-dried slabs were used since limited qualitative tests made on several pulp-type gravity feed disk chippers showed that chipping of air-dried slabs resulted in the better detachment of bark and wood in the chips than chipping of green slabs. All slabs containing at least some attached bark were chipped in an experimental stationary model power-fed Carthage* disk chipper set to produce chips with a ¾″ fiber length. The slabs containing

*The mention of commercial equipment does not imply that it is endorsed or recommended by the Department of Agriculture over other equipment of similar nature not mentioned.

no bark (about 10 per cent of the total) were not chipped in these tests, but in a production process they would be chipped separately and added to the wood fraction thus reducing the average cost of separation and slightly increasing the average purity of the wood chips. The chipper used has a 38″ diameter three-knife disk rotating in a plane about 30° with the horizontal. The horizontal feeding device consists of an upper and lower power-driven chain carriage which stabilizes the feed during chipping and aids in obtaining uniform chip lengths. In operation the slabs are fed in bark side up and the knives enter the bark side of the slab at an angle of 30° with the plane of the slab giving the bark a horizontal thrust which tends to detach the bark chip from the wood and cambium layers. Considerably better detachment of bark and wood was obtained than in a conventional gravity fed disk-type chipper.

A screen analysis of the chips together with a bark and wood analysis of each fraction is given in Table II.

TABLE II

Screen and Bark Analysis of Carthage–Chipped Air–Dried Hemlock Slabs
(10.5% Moisture on Wet Basis)

Screen Size	Retained on Opening	% of Total Wt. Retained	% Wood	% Bark	% Wood and Bark Adhering	% Wood in Adhering Portion	% Bark in Adhering Portion
Initial Material	——	100.0	63.8	36.2	1.0	53.3	46.7
+¾″	0.645″	31.6	72.8	27.1	2.2	31.2	68.8
—¾″ + 2–mesh	0.437″	32.1	69.4	30.5	1.0	30.2	69.8
—2–mesh + 3–mesh	0.279″	23.5	59.5	40.5	0.4	44.4	55.6
—3–mesh + 4–mesh	0.145″	3.3	44.0	55.9	0.1	——	——
—4–mesh + 7–mesh	0.094″	3.0	38.2	61.8	†	——	——
—7–mesh + 10–mesh	0.075″	1.6	37.6	62.4	†	——	——
—10–mesh + 20–mesh	0.0328″	1.0–	27.7	72.3	†	——	——
—20–mesh		3.9–					
		100.0	63.8‡	36.1‡	1.0‡		

† Insignificant amount
‡ Weighted totals

Complete detachment of the wood and bark occurred in 99 per cent of the total chips by weight. It is realized that this material may not be typical of what would be processed commercially. The long storage time undoubtedly favors detachment. Further studies are being made to determine the effect of such factors as the season of felling of the tree, seasoning of the slabs and the final moisture content upon the degree of detachment obtained during chipping.

Screening: Since the specific gravity differences are only moderate, close sizing of the feed material to the "specific gravity" separator is essential for efficient segregation. For this purpose the chips were classified ona 2-deck Roball* gyrating screen into four main fractions—over ¾-inch, over 0.437-inch (2-mesh), over 0.279-inch (3-mesh) and through 0.279-inch. In addition a few large pieces estimated to be over 1½ inches were removed by hand since no suitable large screen was available.

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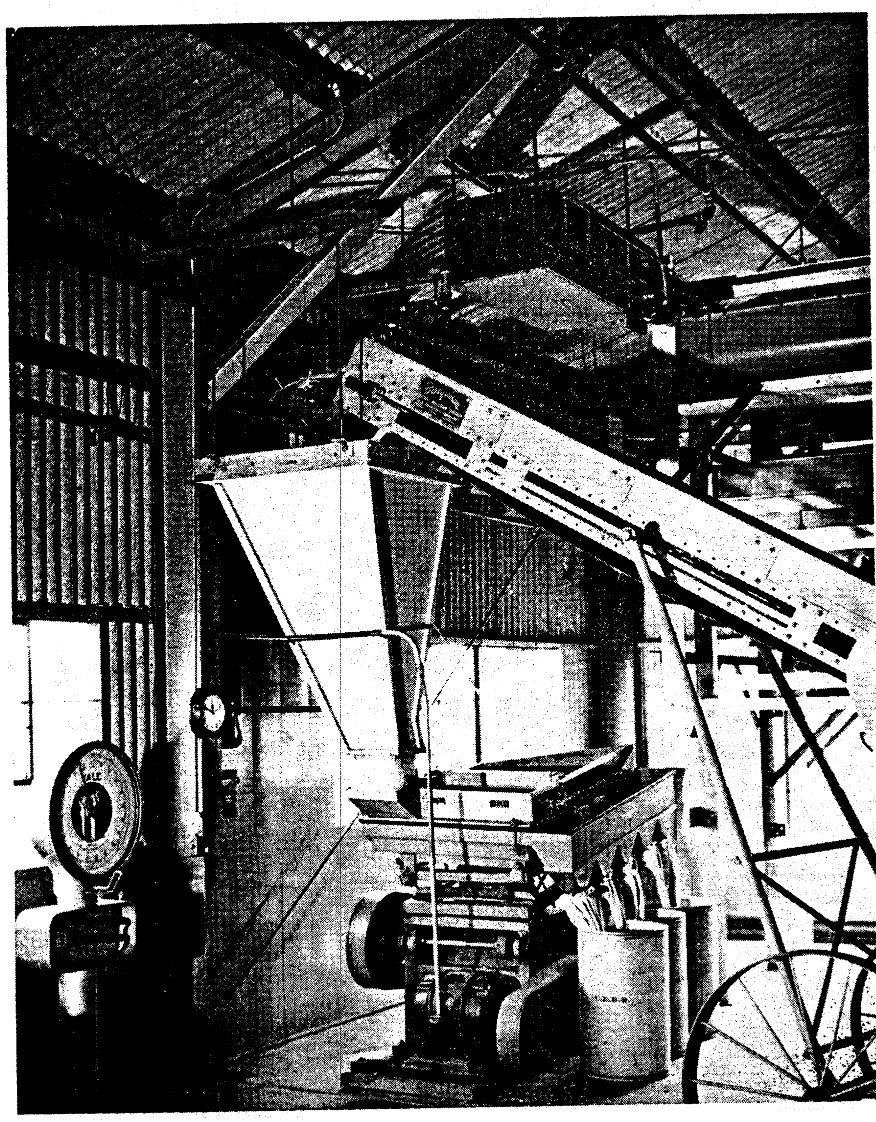

FIGURE 1.—Specific Gravity Air Classifier.

The bark-wood analysis of each screened fraction showed that the bark was more friable than the wood and thus the bark content increased with decrease in particle size. The fines through 0.279-inch, consisting of about 12.8 per cent of the total chips, contained about 64 per cent bark.

Segregation of Bark and Wood: The air flotation specific gravity separator used for this work was a Sutton, Steele and Steele model BX-100* shown in Figure 1. This equipment consists of an oscillating deck covered with a 16-mesh wire screen. Air supplied by a centrifugal fan is delivered through a system of baffles and through the porous covering to form a continuous upward air flow over the entire surface of the deck. The baffles are adjusted so that the maximum air rate is obtained at the rectangular section near the feed port (see Figure 2) with a slight gradual decrease in air velocity along the right deck rail to the so-called heavy end of the deck. There is also a uniform decrease in air velocity toward the light end of the deck where the lightest particles are discharged. The deck used in this work is fitted with tapering

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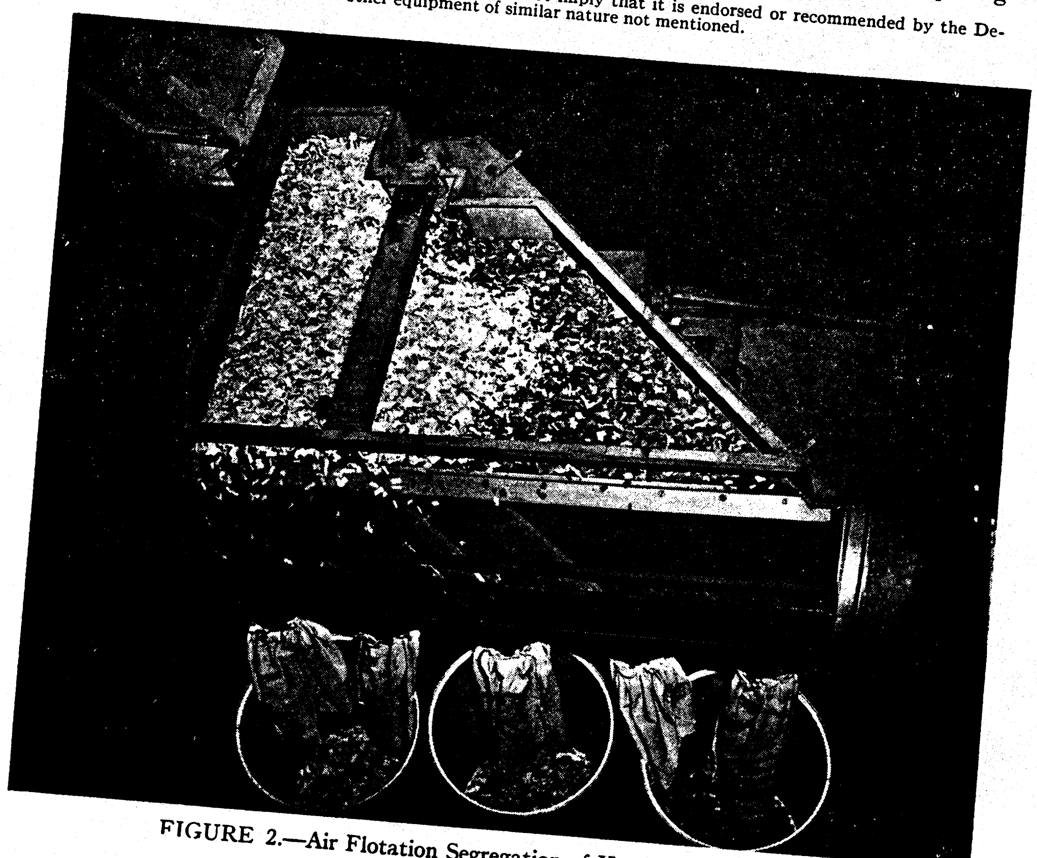

FIGURE 2.—Air Flotation Segregation of Hemlock Slab Chips.

riffles parallel to the deck discharge lip with decreasing height toward the heavy end of the deck. The volume of air delivered by the fan, the oscillating frequency of the deck, and the deck inclination are adjustable, the settings used being dependent upon the terminal velocity or floatability of the light fraction processed.

The feed is stratified into a light layer that floats off the deck surface and a heavy layer that rests on the surface. The light material floats over the riffle bars and migrates to the left or low end of the deck while the heavy pieces are propelled along the riffles toward the high righthand end by the oscillating motion. Material discharged over the deck lip falls into one of five chutes, in this discussion, numbered 1 to 5 from left to right (Figure 2). Adjustable baffles are provided to regulate the proportions of chips falling into each chute. As set up in Figure 2, only two baffles are in use to limit the middling fraction from chute 3. The wood products from chutes 1 and 2 are combined and the bark products from chutes 4 and 5 are combined.

Inspection of the chips showed that the wood was generally in the form of thin plates while the bark and knotty material were more like spheroids. These characteristic shapes tend to enhance the effect of specific gravity and aid their segregation in this equipment since spheroids are less influenced by the upward air flow than flat plates.

The three middle-sized chip fractions from the screening operation (over 0.75-inch, 0.437-inch, and 0.279-inch respectively) were each segregated into 5 fractions on this equipment. The middling fraction, from chute 3, was then refloated to give a finer segregation. In each case the middling fraction included about 25 per cent of the total feed. The flotations were all carried out at a feed rate of about 500 pounds per hour. Tests showed that substantially identical segregations can be obtained at about 1000 pounds per hour feed rate when the deck is fitted with a tail riffle on the lefthand end of the deck and a so-called dead skimmer baffle plate about 6 inches wide attached to the righthand rail.

No flotation separation was attempted on the small coarse fraction over 1½ inches, or upon the finest fraction, through 0.279 inch, since this would serve no practical purpose. The coarse fraction contained no bark and the material through 0.279 inch was too fine to be worth segregation.

Results and Discussion

A lot of 538 pounds of chips was screened and segregated using settings determined by small test runs. The results are shown in Tables III and IV and Figures 3 and 4. The quantities and compositions of the composite products listed in these tables are calculated in proportion to their occurrence in the main lot screened. The chips over 1½″ consisted of a small fraction hand picked from the fraction over ¾ inch. They were mostly knots which are undesirable for either pulping or tannin extraction. This fraction should

TABLE III

Segregation of Bark and Wood from Hemlock Slab Chips by Air Flotation*

Chips Segregated				Wood Products				Middlings				Bark Products			
Screen Fraction				Chute 1		Chute 2		Chute 3		Chute 4		Chute 4		Chute 5	
Over, Inches	Through, Inches	% of * Total Chips	Bark Content %	% of* Total Chips	Bark Content %	% of* Total Chips	Bark Content %	% of* Total Chips	Bark Content %	% of* Total Chips	Bark Content %	% of* Total Chips	Bark Content %	% of* Total Chips	Barkt Conten %
0.75	1.5	31.4	25.4	10.61	0.2	5.19	0.7	7.44	18.1	—	—	2.04	79.2	6.12	81.2
0.437	0.75	32.1	29.9	8.53	0.1	6.23	0.9	8.51	22.1	—	—	4.91	86.6	3.92	86.8
0.279	0.437	23.5	33.9	8.88	0.7	3.34	4.5	4.49	36.7	—	—	2.56	88.2	4.23	91.0
Middlings Reflotation (Chips from Chute 3 above)															
0.75	1.5	7.44	18.1	1.35	0.8	1.87	1.8	1.61	5.5	1.79	35.6	—	—	0.82	70.6
0.437	0.75	8.51	22.1	2.4	0.9	1.9	1.8	3.0	27.3	—	—	0.3	72.6	0.9	88.4
0.279	0.437	4.49	36.7	0.55	3.1	0.62	6.5	2.16	29.2	—	—	0.53	74.2	0.63	89.7

* A total of 538 pounds of chips were processed including fines and material over 1½ inch not floated.

TABLE IV

Composite Products after Chip Segregation Calculated in the Ratio Produced

Fraction				Wood Products		Discards		Bark Products	
Over, Inches	Through, Inches	% of Total Chips	Bark Content, %	% of Total Chips	Bark Content, %	% of Total Chips	Bark Content, %	% of Total Chips	Bark Content, %
1½*	——	0.2	0	——	——	0.2	0	——	——
¾	1½	31.4	25.4	15.8	0.36	——	——	8.2	80.4
0.437	¾	32.1	29.9	14.8	0.44	——	——	8.8	86.7
0.279	0.437	23.5	33.9	12.2	1.7	——	——	6.8	90.1
——	0.279	12.8	64.1	——	——	——	——	12.8	64.1
Middlings Refloated									
¾	1½	7.4	18.1	3.2	1.4	3.4	21.4	0.8	70.6
0.437	¾	8.5	22.1	4.3	1.3	3.0	27.3	1.2	83.4
0.279	0.437	4.5	36.7	1.2	4.9	2.2	29.2	1.2	82.6
Composite Products				51.5	0.96	8.8	24.9	39.7	78.2
Bark in Composite Product, % Total Bark				1.4		6.5		92.1	
Wood in Composite Product, % Total Wood				77		9.9		13.1**	

*Small fraction hand-picked from fractions over ¾ inch.

**Much of the wood chips in the bark product consists of knots which are undesirable for pulping.

be discarded. The fines through 0.279-inch contain too little wood of sufficient fiber length to be worth attempting to segregate for use in pulping. Since the bark content is high (64 per cent) in this fraction it can be added directly to the combined bark fractions for production of tanning material with little decrease in average tannin content or purity.

The chutes from the air deck are numbered from the light end, 1 and 2 producing wood fractions, 3 a "middling" fraction, and 4 and 5 predominantly bark fractions, except for chute 4 from reflotation of the middling fraction over ¾-inch which is also a middling fraction.

The separations obtained in this run gave practical products but an examination of Table III shows that absolutely ideal settings and results were not obtained. For example, the bark contents of the material entering the wood product from chute 2 during the flotation of the material over 0.279-inch and the reflotation of the middlings from the same material are excessive. Also, in the reflotation of the middling over 0.75-inch the bark content of the middling fraction from chute 3 is quite low. Slightly improved results could apparently have been obtained by small changes in the cutting finger locations for the middling fraction, particularly during the reflotation of the middlings.

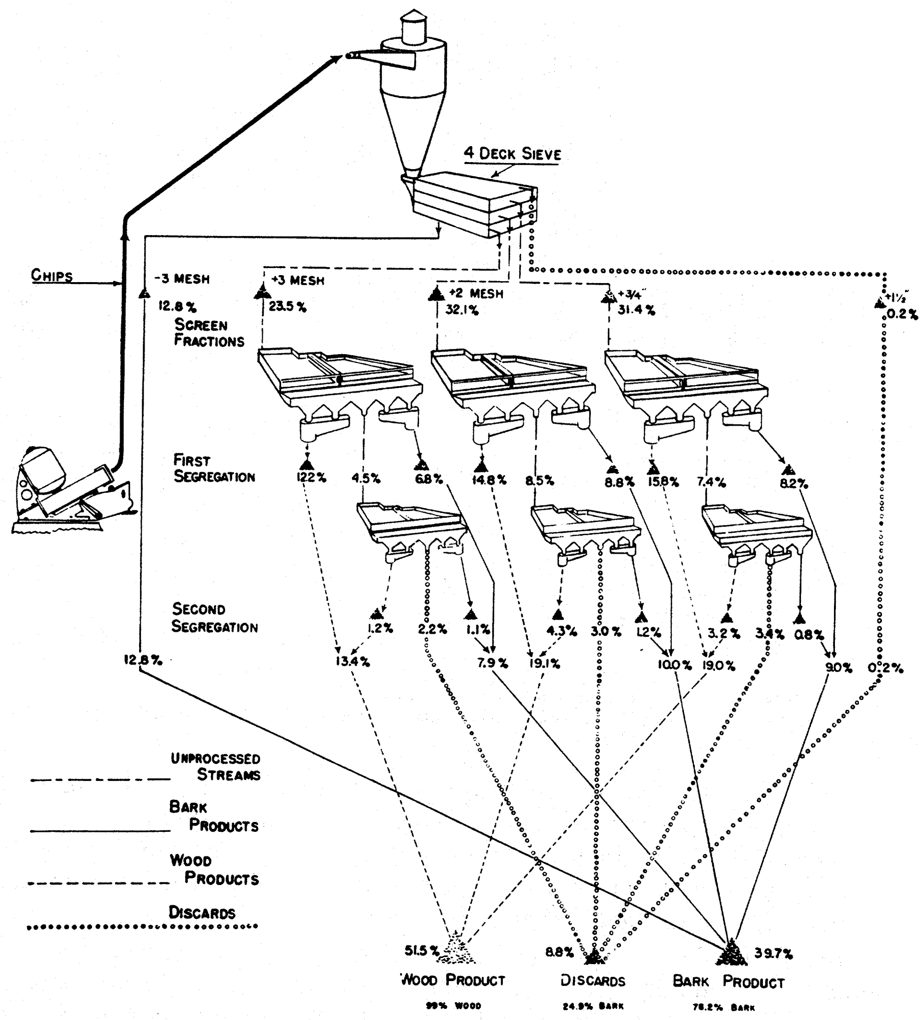

FIGURE 3.—Flow Diagram of Segregation of Wood and Bark from Hemlock Slab Chips.

Continuous recycling of the middlings back into the same flotation separator along with fresh material is not advocated here because the middlings consist of pieces of bark and wood with terminal velocities in the same range, and for this reason would be redischarged over the deck lip at the same location. Recylcing then, would tend to give less satisfactory separation of the wood and bark products. A more practical and better controlled segregation of the middlings can be obtained by refloating them separately. The middlings discarded from each screened fraction were reduced by about ½ or more by this method. Separate processing of the middlings permitted better control of the cuts. Precise settings of the cutting fingers on the initial segregation

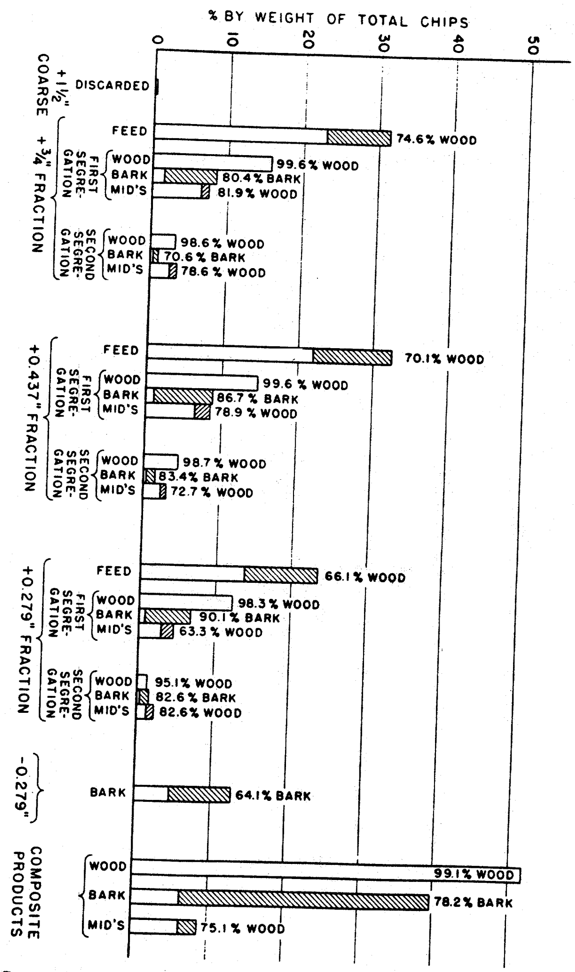

FIGURE 4.—Segregation of Bark and Wood from Air Dried Hemlock Slab Chips.

is difficult at high feed rates. A variation of ½-inch in the position of the cutting finger can materially change the bark content of the wood product. Conservative cuts may be made on the initial segregation when the middlings are processed separately. The middlings table can then be operated at lower feed rates and with more precise cuts since the middling material is now spread across the entire width of the table. A better separation of the middling fraction could be obtained by rescreening all middling fractions prior to re-flotation since these fractions are generally made up of relatively small bark pieces or large wood pieces in addition to particles with adhering bark and wood. This step was not required to obtain good separations with the chips used here, however, and in a production process it is doubtful if additional cost of screening and handling equipment could be justified by the increased yield of wood and bark products.

Products

A flow diagram of the segregation accomplished and the suggested recombination of various fractions to form suitable bark and wood products is shown in Figure 3. By combining all of the heavy fractions and the fines through 0.279-inch a bark product was recovered which contained 78.2 per cent bark and included 92.1 per cent of the total bark and 39.8 per cent of the total chips. By combining all of the light fractions a wood fraction was recovered which contained 99 per cent wood including 77 per cent of the total

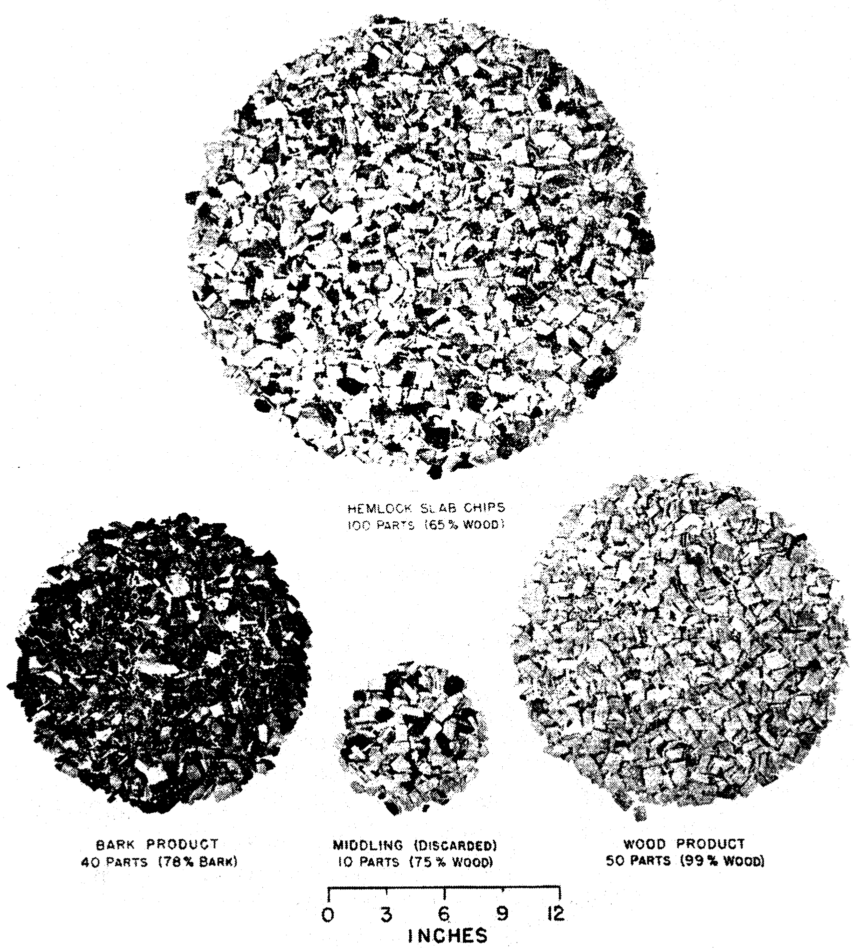

FIGURE 5.—Products Obtained by Air Flotation of Hemlock Slab Chips.

wood and 51.5 per cent of the total chips. Thus over 90 per cent of the slabs with attached bark can be converted into two valuable products and the slabs without attached bark would of course be 100 per cent used in the wood product.

Figure 5 is a photograph of the chips as received and products of the segregation process showing the relative proportion of the products obtained.

The bark product contained 10.3 per cent tannin on the dry basis. The tannin in this fraction had a purity of 66. This product should prove to be a good tannin raw material. Hemlock extract has long been used as a standard tanning material. Its properties are well known to tanners and thus should be readily marketable in the Great Lakes area. Table V gives the analysis of a representative sample of the bark product. The American Leather Chemists Association's standard method of analysis (8) was used.

TABLE V

Tannin Analysis of Bark Product

Soluble Solids, M. F. B.	15.59%
Soluble Nontannins, M. F. B.	5.26%
Tannin, M. F. B.	10.33%
Purity-basis of Soluble Solids	66.26%

The wood product, containing over 99 per cent wood should be an attractive source of pulp wood to paper and paperboard manufacturers who can tolerate a small amount of bark in their pulps. It would be highly satisfactory in all Kraft mills where hemlock fiber is used. The wood chips are quite uniform as to fiber length, free of hard knots and containing very little "dirt" or wood dust. These chips could be fed directly into digesters for pulping or mixed with the regular pulpwood chips at the paper mill.

Samples of pulp chips, containing 2 per cent bark, which were produced in an earlier air flotation experiment from chips containing an excessive fraction with attached bark and wood were submitted to several pulpmills for evaluation. This material was too high in bark content for use in sulfite mills producing quality paper but it was a satisfactory pulping material for a Kraft mill in the Upper Peninsula that was producing quality liner board.

The process described here can be altered to give different products if the market conditions and prices should warrant it. For example, if a wood product containing less bark could sell at a sufficient premium it would be possible by combining the proper fractions to produce a product containing 99.7 per cent wood consisting of 28 per cent of the total chips together with one containing 98.3 per cent wood and consisting of 23.5 per cent of the total chips. On the other hand, by adjusting the cuts on the middlings table the auxiliary wood product could be increased and made to meet a specification of 95 per cent wood. This would result in a discard portion of only about 5 per cent including the 1½ inches overs. Furthermore, if such markets are not available and it is desirable to produce a 95 per cent wood product only, as would be likely if paperboard manufacturers are to be supplied, then by combining all of the middling portions a wood product containing 95.6 per cent wood and consisting of about 60 per cent of the total slabs could be produced. The plus 1½ inch knots would then be the only portion discarded or used for fuel. These variations would not change the bark product.

Preliminary cost estimates indicate that the process will be of commercial interest if the separation of bark and wood obtained in these chipping and segregation tests could be obtained commercially. At the present time work on the effect of moisture content and age of the slabs as well as the felling period of the logs on the chipping and subsequent segregation is being investigated so that definite recommendations as to the condition of the raw material can be made.

As suggested by the work of Calderwood and May [2] and by Snow [4] the possibility of segregating bark and wood from chipped round wood such as tree tops and limbs should be investigated. Use of such material could prove very valuable in reducing logging residues. In-the-woods-chipping would be involved and seasoning of the round wood may be required with the added problem of transporting chips from the logging area to the processing plant. It is probable that detachment of bark and wood during the chipping of round wood would be reduced with consequent loss of efficiency in the segregation of the bark and wood.

Summary

A large volume of hemlock slabs and edgings is largely wasted each year at sawmills in the Upper Peninsula of Michigan. The segregation and recovery of hemlock bark from these slabs for use as a tanning material source is considered here. A test lot of year-old air-dried hemlock slabs was chipped in a power-fed disk-type chipper. The chips were then size classified by screening into 5 fractions. The coarsest fraction. which contained largely knots, was discarded. The three middle fractions were each segregated on an air flotation specific gravity separator to produce a wood product, a bark product and a middling fraction. The middling fractions were then refloated to give additional wood and bark products. The bark fractions blended together with the finest screened fraction which was not air floated gave a combined bark product which contained over 10 per cent tannin and included about 92 per cent of the total bark in the slabs. The combined wood product contained 99 per cent wood and included 77 per cent of the total wood in the slabs.

The process could be adjusted to produce wood chips with somewhat less bark but with a lower yield, or if more bark could be tolerated in the wood chips a higher yield could be obtained.

Acknowledgment

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References

1. Rogers, J. S. "Native Sources of Tannin Materials"; "Crops in Peace and War", Yearbook of Agriculture 1950-1951; *U.S.D.A.* p. 709.
2. Calderwood, H. N. and May, W. D., "Scrub Oak as a Potential Replacement for Chestnut", *J.A.L.C.A.* **42,** 62 (1947).
3. Rogers, J. S., Calderwood, H. N. and Beebe, C. W. "Study of Tannin Content of Barks from the Florida Scrub Oaks, Quercus laevis and Q. cinera". *J.A.L.C.A.* **45,** 733 (1952).
4. Snow, E. A. "Oak Slabs and Cordwood as a Source of Tannin and Pulp". *J.A.L.C.A.* **47,** 563 (1952).
5. Beebe, C. W., Luvisi, F. P. and Happich, M. H. "Tennessee Valley Oak Bark as a Source of Tannin" *J.A.L.C.A.* **48,** 32 (1953).
6. Rogers, J. S. "Potential Tannin Supplies from Domestic Barks" Bulletin No. 39 "Tannin from Waste Bark" Sept. 1952 Northeast Wood Utilization Council.
7. Smoot, C. L. and Frey, R. W. "Western Hemlock Bark an Important Potential Tannin Material" Tech. Bull. No. 566 *U.S.D.A.* April 1937.
8. The American Leather Chemists Association "Methods of Sampling and Analysis".
9. Dunwoody, A. B., "Wood-Chip Preparation for Digesters from Unbarked Logs", U.S. Patent 2,596,015, May 6, 1952.